Remembering Leiba Rodman 1949–2015, at IWOTA 2015

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Remembering Leiba Rodman 1949–2015, at IWOTA 2015

J.A. Ball, M.A. Kaashoek, A.C.M. Ran and I.M. Spitkovsky

Abstract. The present article covers the contributions of the speakers at the memorial session "Remembering Leiba Rodman" at IWOTA 2015.

1. Introduction (by Rien Kaashoek)

On March 2, 2015 Leiba Rodman, vice president and long time member of the IWOTA Steering Committee, passed away. In the preceding year at the IWOTA conference in Amsterdam we celebrated his 65th birthday. The emphasis then was on his outstanding mathematical work. The conference organizers honored him

with a special session on *Operators, matrices and indefinite inner products*, and by inviting him as a plenary speaker at the session.

At the half-hour memorial session organized at IWOTA 2015, the emphasis was different. We did not celebrate, we mourned. We remembered Leiba as a wonderful human being, a great friend, an excellent co-author, and a dear colleague whom we dearly miss. The present article covers the contributions of the four speakers.

Leiba was born on June 9, 1949 in Riga, the capital of the Baltic country Latvia. In 1971 he and his parents emigrated to Israel where he got a master degree in 1976 at Tel-Aviv University, on a thesis entitled *The many-armed bandit problem*. So far no IWOTA topics. At that time Leiba went to see Israel Gohberg and asked him to be his Ph.D. advisor. This changed his research direction if not his life.

Leiba and I met for the first time at Tel-Aviv University in April 1977 when he was still a Ph.D. student.

From right to left: Peter Lancaster, Leiba Rodman, Israel Gohberg, Leonia Lerer, Rien Kaashoek, on the stairs to the old entrance of the math institute of Tel-Aviv University, April 1977.

The next year 1978 was a remarkable year for Leiba. In that year appeared his first publications, not just one or two papers but eleven, including a paper in Annals of Probability based on his master thesis. Main theme in the ten other papers was the spectral analysis of matrix polynomials which he started with Israel

Gohberg and Peter Lancaster, and which resulted in their 1982 book and in Leiba's 1989 book on Operator Polynomials. Among these 11 papers there were two papers on families of operator polynomials and generalized Vandermonde matrices which the two of us wrote jointly with Israel Gohberg. Eleven publications in one year happened more often in Leiba's career. In the course of the years Leiba developed a large group of co-authors and mathematical friends around him. MathSciNet lists 91 co-authors.

I got to know Leiba as a great problem solver, a very productive writer, a reliable friend, and a man with a great sense of humor. When at the beginning of the day at the math department at the VU in Amsterdam I would ask him: "Hi Leiba, how are you doing today?" he usually would answer: "I don't know yet, it is too early to say." I remember with pleasure the three papers we worked on in Amsterdam in the early eighties jointly with Cornelis van der Mee, extending the spectral theory of operator polynomials to analytic operator-valued functions with compact spectrum, solving factorisation, divisibility, and inverse problems on the way. Topics we did return to in our last joint paper with Israel Gohberg in 1994 in the problem book [1]. In his email from February 8, 2015 (his last one to me) Leiba wrote:

> *I just started the* (*third*) *chemotherapy, it is planned for about* 6 *months. So far so good. Hope for the best.*

The best did not come. We lost a great mathematical friend.

References

[1] I. Gohberg, M.A. Kaashoek and L. Rodman, Local and global analytic equivalence of analytic operator functions, in: *Linear and Complex Analysis Problem Book* 3, Part I, (V. Havin and N.K. Nikolski eds.), Springer Verlag, Berlin, 1994; pp. 205–206.

2. My meetings with Leiba (by Joe Ball)

The time was July 1979, the occasion was the International Symposium on the Mathematical Theory of Networks and Systems (MTNS) hosted by Patrick Dewilde at the Delft Institute of Technology in Delft. I had heard of the first informal MTNS held in College Park (Maryland) in 1973 and had actually ventured to the next one in Montreal in 1975. I passed up the one in Lubbock (Texas) in 1977, but after a couple of years being exposed to the connections between operator theory and engineering through working with Bill Helton, I was ready to trek across the ocean for the one after that in Delft in 1979. It was here that I saw Leiba Rodman in the flesh for the first time. There was a fire hose of new information for me: Bart, Gohberg and Kaashoek gave a coordinated sequence of lectures on their new book just coming out [2], and Gohberg, Lancaster, and Rodman were giving a coordinated series of lectures on their substantial work on matrix polynomials (leading to the soon-to-appear book [3]). My early work had to do with

some narrow aspects of the Livšic/Sz.-Nagy–Foias model theory and characteristic function; now I was seeing versions of the characteristic function popping up all over the place and I became determined to understand the connections. I made a lot of new contacts at this Delft meeting, eventually leading to the decision to spend a sabbatical year at the Weizmann Institute of Science in Rehovot, Israel for the first 6 months of 1983.

It was during this period that I got to know Leiba better, including the privilege of being an invited guest (with my recent bride Amelia) at his wedding. It was at this point that I began working with Israel Gohberg; one thing led to another and by the time of the NSF-CBMS conference in Lincoln (Nebraska) in 1985 it was decided that the three of us (myself, Israel, and Leiba) should write a book on interpolation of rational matrix functions. The resulting tome [1] finally appeared in 1990. The activity in between to get this done is summarized best in the Preface from the book:

> *... The* [*Nebraska*] *conference was very stimulating and helped us to decide that the time was ripe for a book on interpolation for matrix-valued functions* (*both rational and non-rational*)*. When the work started and the first partial draft of the book was ready it became clear that the topic is vast and that the rational case by itself with its applications is already enough material for an interesting book. In the process of writing the book, methods for the rational case were developed and refined. As a result we are now able to present the rational case as an independent theory. After two years a major part of the first draft was prepared. Then a long period of revising the original draft and introducing recently acquired results and methods followed. There follows a period of polishing and of* 25 *chapters and the appendix commuting at various times somewhere between Williamsburg, Blacksburg, Tel Aviv, College Park and Amsterdam* (*sometimes with one or two of the authors*)*. It took us four years to complete the whole project. Much of this time was spent on filling in the gaps and missing connections between different parts of the theory. If the reader finds a unified and appealing basic theory as a result of all these efforts, the authors will be gratified.*

This extended quote gives the feel for the level of intensity devoted to this project at the time, with the drive and attention to detail of Leiba a major force behind the limiting of the duration of the project to a mere four years! Of course this is just one of 8 books for which Leiba is the sole or a co-author.

About a year before Leiba's passing, a question concerning matrix polynomials came out of Universität Konstanz in Germany:

> *Given a square matrix polynomial* $P \in \mathbb{C}[z]^{n\times n}$ *with positive semidefinite values on the real line and given a Fejér–Riesz factorization* $\det P(z) = |g(z)|^2$ *for its determinant* (*where* g *is a scalar polynomial in* z)*, can one find a matrix Fejér–Riesz-type factorization* $P(z) = Q(\overline{z})^* Q(z)$ *so that* $\det Q(z) = g(z)$*?*

The answer turns out to be affirmative but via a variety of different methods:

(1) there is a direct elementary algebraic proof due to Markus Schweighofer and Christoph Hanselka of Konstanz, who originally asked the question;
(2) there is a proof based on the Ball–Gohberg–Rodman theory of null-pairs for rational matrix matrix functions (specialized to the polynomial case);
(3) there is a proof based on the more specialized Gohberg–Lancaster–Rodman analysis of local zero structure for Hermitian matrix polynomials.

Leiba was very modest about this result: it was essentially already known – one needed only to put together some pieces of existing theory. Needless to say Leiba had already moved on from matrix polynomial and rational functions over $\mathbb{C}$: his last (sadly to say) book is on linear algebra over the quaternions [4]. I shall miss him greatly as a long-time friend and collaborator.

References

[1] J.A. Ball, I. Gohberg, and L. Rodman, *Interpolation of Rational Matrix Functions*, Oper. Th. Adv. Appl. **45**, Birkhäuser Verlag, Basel, 1990.

[2] H. Bart, I. Gohberg, and M.A. Kaashoek, *Minimal Factorization of Matrix and Operator Functions*, Oper. Th. Adv. Appl. **1**, Birkhäuser Verlag, Basel, 1979.

[3] I. Gohberg, P. Lancaster, and L. Rodman, *Matrix Polynomials*, Academic Press, New York, 1982.

[4] L. Rodman, *Topics in Quaternion Linear Algebra*, Princeton Series in Applied Mathematics, Princeton University Press, Princeton, 2014.

3. Leiba – my top coauthor (by Andre Ran)

In October 1981 there were quite a number of visitors at the mathematics department of the Vrije Universiteit in Amsterdam. The occasion was the official PhD defence of two candidates: Bert den Boer on October 15 and Cornelis van der Mee on October 21. Connected to these festivities Rien Kaashoek organized a number of lectures to be held in the Seminar Analysis and Operator Theory at the VU. One of the lecturers, on October 12, was Leiba Rodman, who had been a regular visitor of the VU in the years before, and who was also involved in the PhD defences. Leiba lectured on Hermitian solutions of Algebraic Riccati equations. At the end of the lecture Israel Gohberg asked a question: "What about stability?". In the ensuing discussion it became clear that the question was how solutions of the Riccati equation behave under small perturbations of the coefficients in the equation.

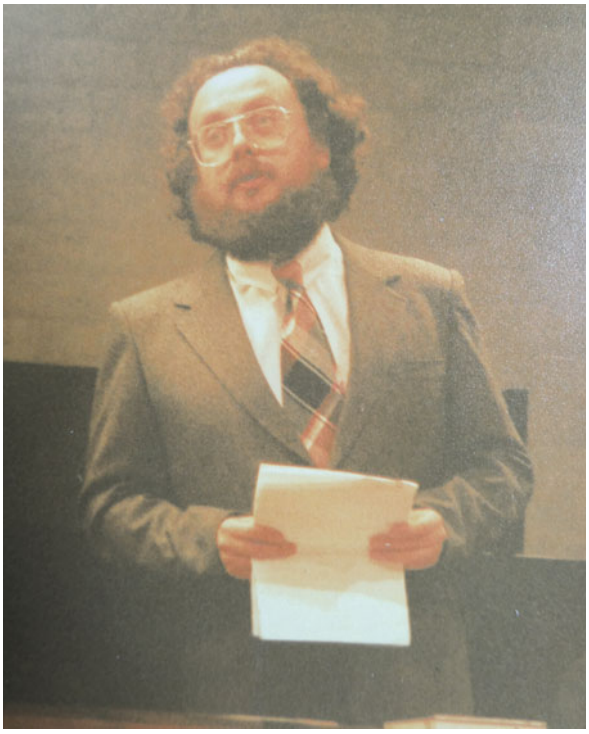
This question was the start of a collaboration between Leiba and myself. In the weeks after his lecture we worked on several parts of the problem, and when Leiba visited a year later he lectured on our joint work, on October 7, 1982, with the title *Stability of invariant maximal semidefinite subspaces*. In that period we shared an office at the VU for a couple of months, and we became close friends. A

friendship that lasted till his premature death, and a collaboration that resulted in more than fifty papers.

To give a sample of the results we produced in that early period, the following theorem (or its friend) was proved on a stack of beer-coasters in a pub in the Voetboogsteeg in Amsterdam by Leiba Rodman and me. Unfortunately the beer coasters have been discarded; we wrote up the proof the day after.

Theorem 1. *Let A be an H-selfadjoint matrix. Then the following are equivalent:*

1. *There exists a stable A-invariant maximal H-nonnegative subspace,*
2. *There exists a unique A-invariant maximal H-nonnegative subspace $\mathcal{M}$ with $\sigma(A|_{\mathcal{M}}) \subset \mathbb{C}^+$,*
3. *The pair (A, H) satisfies the sign condition.*



Leiba as an "opponent" at my PhD defence in 1984

Over the years, we worked intensively together, in Williamsburg where I spent a semester as a visiting professor in 1990, in Amsterdam at numerous occasions, and since 2003 also in Berlin, where for a period we both visited yearly for a week of intensive work in December. With our hosts, Christian Mehl and Volker Mehrmann, we shared an interest in matrix problems in spaces with an indefinite inner product structure, and we co-authored many joint papers on the subject. In fact, when Leiba visited in Amsterdam in 2014 on the occasion of the IWOTA

conference (which was also partly in honor of his 65th birthday), plans were made to continue the investigation.


Discussion in Amsterdam in June 2014

With deep regret we must face the fact that such discussion are now for ever impossible, but with great joy and gratitude all the time we spent together is remembered.

2007 in Zacatecas, Mexico

4. From East to West (by Ilya Spitkovsky)

In August 1988 a conference was held in Calgary on "Operator Theory: Advances and Applications", devoted to the 60th anniversary of Israel Gohberg. These were "perestroika" years in the Soviet Union, and (still somewhat surprisingly) I managed to obtain the permission to travel – for the first time in my life, – to a capitalist country, and attended the conference as part of a "Soviet delegation". This was a life-changing experience in many ways, which facilitated my move to the USA shortly thereafter, and this is also where I met Leiba for the first time.

In February of 1990, while waiting in Italy for a permission to enter the United States, I called Leiba on the phone and brought him up to date on my whereabouts. This led to a job interview at William & Mary two months later, and a visiting position there for the next academic year (1990–91) which eventually turned into a permanent one.

This appointment was the beginning of our collaboration, which lasted a quarter of a century. By the number of joint publications (38) Leiba was my top coauthor, and I ranked third on his list, after Israel Gohberg and André Ran. I had therefore plenty of opportunities to observe Leiba "in action" but must admit that I never was able to comprehend how he managed to simultaneously (and successfully) work on multiple projects. He used to tell me that he followed a simple rule of giving priority to the project which at the time was the closest to completion. A good rule, but I am sure that was not all ....

Here is one example: In the Fall of 1990 we were working on our first joint (also with L. Gurvits) paper [1]. At some point the results were mostly obtained, but nothing was yet in writing, and Joe Ball was about to arrive on campus to work with Leiba on something completely different. So, next morning Leiba hands me the first draft (very close to the final version) which he had prepared in the evening the day before, realizing that the next couple of days he will be busy with Joe. Another example: The William & Mary Math Department has been running the so called Research Experience for Undergraduates summer program on and off (mostly on) since 1989. This is an eight week long highly selective program in which teams of one-two faculty members paired with one-two students work on research problems of mutual interest. Overall, this is a very successful endeavour, in most cases eventually leading to joint publications. As a rule, however, there is a rather significant gap between the official end of the program and the submission of the paper: the results need to be polished, checked, carefully written down etc. In my experience there were only two cases when the paper was actually submitted even before the end of the program. Needless to say, in both cases the project was supervised jointly with Leiba. Incidentally, one of them [2] became my most cited paper.

I mentioned above my first joint paper with Leiba. Sadly, now the notion of the last one [3] is well defined. This last paper with Leiba was written jointly also with Stephan Weiss and Aleta Szkoła, and was started when Stephan and Leiba met at the workshop LAW'14 in Ljubljana, Slovenia. I was already at the New

York University Abu Dhabi at the time, and we worked on this project remotely, via email. Here is the last pertinent communication I received from Leiba, dated January 11, 2015:

Dear Ilya, Stephan, Arleta. Re rssw1a.tex I looked over the file and its looks good. There are a few corrections to be made, but I did not change the file. I suggest that we move to finalize the paper.

On a personal level, I will go through chemotherapy during several months, most likely including Spring and Summer 2015*. I have requested medical leave for the Spring semester of* 2015*. I may be out of loop during this period. Wish me luck. Best regards, Leiba.*

And here is another one, two weeks later, concerning what was supposed to become our 39th joint work:

> *Dear Ilya. Thanks for your message. Please send me your comments first, before sharing them with others. My treatment did not start yet, I need to do some tests before my doctor will decide on the treatment. By the way, perhaps you remember the plan to submit a joint paper for the iwota* 2014 *proceedings. As it turns out, I am not up to this task, so I suggest to scrap this plan* (*regretfully*)*. Best regards, Leiba.*

Leiba passed away on March 2nd that year. I miss him greatly as an impeccable and impartial colleague, a long term collaborator, and as a friend.

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5. Biography

Education, academic degrees, institutions and dates

- 1966–1971 Diploma (approximately equivalent to M.S. degree) in Mathematics from Latvian State University, Riga, Latvia. Thesis: "on the augmentation ideal in group algebras".
- 1974–1976 M.A. degree (with distinction) in Statistics- Operations Research from Tel-Aviv University, Tel-Aviv, Israel. Thesis: "On the many-armed bandit problem".
- 1974–1978 Ph. D degree (with distinction) in Mathematics from Tel-Aviv University, Tel-Aviv, Israel.

Academic Positions

- 1973–1978. Instructor, Tel-Aviv University, Tel-Aviv, Israel.
- 1979–1980. Instructor (part-time), University of Calgary, Calgary, Alberta, Canada.
- 1980–1981 Visiting Scientist, VU University, Amsterdam, The Netherlands.
- 1981–1983 Senior Lecturer, Tel-Aviv University, Israel.
- 1983–1987 Associate Professor Tel-Aviv University, Israel.
- 1984–1987 Associate Professor, Arizona State University, Tempe, Arizona.
- Fall 1986 Visiting Associate Professor, University of California, San Diego.
- 1987–1989 Professor, Arizona State University, Tempe, Arizona.
- 1987–1988 Visiting Professor, College of William and Mary, Williamsburg, Virginia.
- 1988–2015 Professor, College of William and Mary, Williamsburg, Virginia

Services

- Associate/Advisory/Senior Editor, Linear Algebra and its Applications (since 1988),
- Associate Editor, Integral Equations and Operator Theory (since 2003),
- Editor-in-Chief, Operators and Matrices (since 2006),
- Associate Editor, Complex Analysis and Operator Theory (since 2006), Editorial Advisory Board, Concrete Operators (since 2012),
- Steering Committee, International Workshops in Operator Theory and its Applications (since 1987, vice president since 2008),
- Advisory Committee (chair), International Linear Algebra Society (2002–2005).

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